CLAIMS

We claim:

[c1] 1. A heating element comprising:

a flexible substrate; and

a plurality of conductive strands supported by the flexible substrate, each of the conductive strands having:

a core portion; and

a conductive portion carried by the core portion, wherein each of the conductive strands is configured to generate heat by conducting electricity.

[c2] 2. The heating element of claim 1 wherein the flexible substrate includes a fabric material, and wherein the plurality conductive of strands are interwoven with the fabric material.

[c3] 3. The heating element of claim 1 wherein the flexible substrate includes a nylon weave, and wherein the plurality of conductive strands are interwoven with the nylon weave.

[c4] 4. The heating element of claim 1 wherein the flexible substrate includes a fabric material, wherein each of the conductive strands includes a non-conductive core and metallic plating, and wherein the plurality of conductive strands are interwoven with the fabric material.

[c5] 5. The heating element of claim 1 wherein the flexible substrate includes a nylon weave, wherein each of the conductive strands includes a nylon core with a silver portion, and wherein the plurality of conductive strands are interwoven with the nylon weave.

[c6] 6. The heating element of claim 1 wherein the core portion of each of the conductive strands is at least generally non-conductive.

[c7] 7. The heating element of claim 1 wherein the conductive portion of each of the conductive strands includes metal.

[c8] 8. The heating element of claim 1 wherein each of the conductive strands includes a nylon core with metallic plating.

[c9] 9. The heating element of claim 1 wherein each of the conductive strands includes a nylon core with silver plating.

[c10] 10. The heating element of claim 1 wherein the conductive portion of each of the conductive strands includes silver having a thickness of about 100 microns or less.

[c11] 11. The heating element of claim 1 wherein the conductive portion of each of the conductive strands includes silver having a thickness of about 10 microns or less.

[c12] 12. The heating element of claim 1 wherein the conductive portion of each of the conductive strands includes silver having a thickness of about 5 microns or less.

[c13] 13. The heating element of claim 1 wherein the plurality of conductive strands forms a non-linear pattern on the flexible substrate.

[c14] 14. The heating element of claim 1 wherein the plurality of conductive strands forms a repeating geometric pattern on the flexible substrate.

[c15] 15. The heating element of claim 1, further comprising a plurality of non-conductive strands, wherein each of the non-conductive strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns supported by the flexible substrate.

[c16] 16. The heating element of claim 1, further comprising a plurality of non-conductive strands, wherein each of the non-conductive strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns, and wherein the plurality of conductive yarns are woven into the flexible substrate.

[c17] 17. The heating element of claim 1, further comprising:

a first conductive lead supported by the flexible substrate, the first conductive lead coupled to the plurality of conductive strands and configured to be biased at a first electrical potential; and

a second conductive lead supported by the flexible substrate and spaced apart from the first conductive lead, the second conductive lead coupled to the plurality of conductive strands and configured to be biased at a second electrical potential to cause electrical current to flow through each of the conductive strands and generate heat.

[c18] 18. The heating element of claim 1 wherein the core portion of each of the conductive strands includes nylon yarn of about 100 denier or less.

[c19] 19. The heating element of claim 1 wherein the core portion of each of the conductive strands includes nylon yarn of about 33 denier or less.

[c20] 20. The heating element of claim 1, further comprising a plurality of polyester strands, wherein each of the polyester strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns, wherein the plurality of conductive yarns are interwoven with the flexible substrate.

[c21] 21. The heating element of claim 1, further comprising a plurality of polyester strands of about 150 denier or less, wherein each of the polyester strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns, wherein the plurality of conductive yarns are interwoven with the flexible substrate.

[c22] 22. The heating element of claim 1, wherein each of the conductive strands includes a nylon core of about 33 denier or less having silver plating with a thickness of about 5 microns or less.

[c23] 23. The heating element of claim 1, wherein the each of the conductive strands includes a nylon core of about 33 denier having silver plating with a thickness of about 5 microns or less, and further comprising a plurality of polyester strands of about 150 denier or less, wherein each of the polyester strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns, wherein the plurality of conductive yarns are interwoven with the flexible substrate.

[c24] 24. The heating element of claim 1 further comprising a plurality of non-conductive strands, wherein each of the non-conductive strands is entwined with at least two of the conductive strands to form a plurality of conductive yarns supported by the flexible substrate.

[c25] 25. The heating element of claim 1 wherein each of the conductive strands includes a nylon core with silver plating, and further comprising a plurality of non-conductive strands, wherein each of the non-conductive strands are entwined with at least two of the conductive strands to form a plurality of conductive yarns supported by the flexible substrate.

[c26] 26. The heating element of claim 1 wherein the conductive strands are at least generally radiolucent.

[c27] 27. The heating element of claim 1 wherein the conductive strands are at least generally transparent to x-ray imaging.

[c28] 28. The heating element of claim 1 wherein the conductive strands are at least generally transparent to x-ray imaging in an x-ray field having a strength of about 100 Roentgens or less.

[c29] 29. A heating element comprising:

a flexible substrate; and

a plurality of conductive strands supported by the flexible substrate, each of the conductive strands having a silver portion configured to generate heat by conducting electricity.

[c30] 30. The heating element of claim 29 wherein the flexible substrate includes a fiber weave, and wherein the plurality conductive of strands are woven into the fiber weave.

[c31] 31. The heating element of claim 30 wherein the fiber weave includes a cloth material.

[c32] 32. The heating element of claim 29 wherein the flexible substrate includes a nylon weave, and wherein the plurality of conductive strands are interwoven with the nylon weave.

[c33] 33. The heating element of claim 29 wherein each of the conductive strands includes a silver portion having a thickness of about 100 microns or less.

[c34] 34. The heating element of claim 29 wherein the plurality of conductive strands forms a non-linear pattern on the flexible substrate.

[c35] 35. The heating element of claim 29 wherein the plurality of conductive strands forms a repeating geometric pattern on the flexible substrate.

[c36] 36. The heating element of claim 29, further comprising a plurality of non-conductive strands, wherein each of the non-conductive strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns supported by the flexible substrate.

[c37] 37. The heating element of claim 29, further comprising:

a first conductive lead supported by the flexible substrate, the first conductive lead coupled to the plurality of conductive strands and configured to be biased at a first electrical potential; and

a second conductive lead supported by the flexible substrate and spaced apart from the first conductive lead, the second conductive lead coupled to the plurality of conductive strands and configured to be biased at a second electrical potential to cause electrical current to flow through each of the conductive strands and generate heat.

[c38] 38. The heating element of claim 29 wherein the conductive strand is at least generally radiolucent.

[c39] 39. The heating element of claim 29 wherein the conductive strand is at least generally transparent to x-ray imaging in an x-ray field having a strength of about 100 Roentgens or less.

[c40] 40. A heating element comprising:

a flexible substrate; and

at least one conductive path supported by the flexible substrate, the conductive path defining a repeating geometric pattern extending across at least a portion of the flexible substrate, wherein the conductive path is configured to generate heat by conducting electricity.

[c41] 41. The heating element of claim 40 wherein the at least one conductive path defines a repeating Greek key pattern extending across at least a portion of the flexible substrate.

[c42] 42. The heating element of claim 40 wherein the at least one conductive path includes a plurality of conductive paths, wherein each of the plurality of conductive paths defines a repeating geometric pattern extending across at least a portion the flexible substrate.

[c43] 43. The heating element of claim 40 wherein the at least one conductive path is a first conductive path defining a non-linear pattern, and further comprising at least a second conductive path defining an at least generally linear pattern extending across at least a portion of the flexible substrate, wherein the second conductive path is configured to generate heat by conducting electricity.

[c44] 44. The heating element of claim 40 wherein the at least one conductive path is a first conductive path defining a non-linear pattern, and further comprising at least a second conductive path defining an at least generally linear pattern extending across at least a portion of the flexible substrate, wherein the second conductive path is configured to generate heat by conducting electricity, and wherein the second conductive path intersects the first conductive path at at least one location on the flexible substrate.

[c45] 45. The heating element of claim 40 wherein the at least one conductive path is a first conductive path defining a non-linear pattern, and further comprising a plurality of at least generally linear conductive paths extending across at least a portion of the flexible substrate, wherein the plurality of at least generally linear conductive paths are configured to generate heat by conducting electricity, and wherein the plurality of at least generally linear conductive paths intersect the first conductive path on the flexible substrate to form a conductive intersection.

[c46] 46. The heating element of claim 40 wherein the at least one conductive path includes at least a portion of a conductive strand supported by the flexible substrate, the conductive strand having:

a core portion; and

a conductive portion carried by the core portion.

[c47] 47. The heating element of claim 40 wherein the at least one conductive path includes at least a portion of a conductive strand supported by the flexible substrate, the conductive strand having:

a non-conductive core portion; and

a metallic portion carried by the core portion.

[c48] 48. The heating element of claim 40 wherein the at least one conductive path includes a plurality of conductive strands supported by the flexible substrate.

[c49] 49. The heating element of claim 40 wherein the flexible substrate includes a cloth material, and wherein at least a portion of the at least one conductive path is interwoven with the cloth material.

[c50] 50. The heating element of claim 40, further comprising:

a first conductive lead supported by the flexible substrate, the first conductive lead coupled to the at least one conductive path and configured to be biased at a first electrical potential; and

a second conductive lead supported by the flexible substrate and spaced apart from the first conductive lead, the second conductive lead coupled to the at least one conductive path and configured to be biased at a second electrical potential to cause electrical current to flow through the at least one conductive path and generate heat.

[c51] 51. The heating element of claim 40 wherein the at least one conductive path is at least generally transparent to x-ray imaging.

[c52] 52. The heating element of claim 40 wherein the at least one conductive path includes a conductive ink applied to the flexible substrate.

[c53] 53. The heating element of claim 40 wherein the at least one conductive path includes a conductive carbon ink applied to the flexible substrate.

[c54] 54. The heating element of claim 40 wherein the at least one conductive path includes a conductive film applied to the flexible substrate.

[c55] 55. A patient warming device usable to warm a person, the patient warming device comprising:

a support portion configured to support at least part of the person;

a flexible substrate positioned at least proximate to the support portion; and

a plurality of conductive strands supported by the flexible substrate, each of the conductive strands having a core portion and a conductive portion carried by the core portion, wherein the conductive strands

are configured to generate heat to warm the person when the person is positioned at least partially on the support portion.

[c56] 56. The patient warming device of claim 55 wherein the flexible substrate includes a fabric material, and wherein the plurality conductive of strands are woven into the fabric material.

[c57] 57. The patient warming device of claim 55 wherein the flexible substrate includes a fiber weave, wherein each of the conductive strands includes a nylon core with metallic plating, and wherein the plurality of conductive strands are interwoven with the fiber weave.

[c58] 58. The patient warming device of claim 55 wherein the flexible substrate includes a fiber weave, wherein each of the conductive strands includes a silver portion, and wherein the plurality of conductive strands are interwoven with the fiber weave.

[c59] 59. The patient warming device of claim 55 wherein the core portion of each of the conductive strands is at least generally non-conductive.

[c60] 60. The patient warming device of claim 55 wherein the conductive portion of each of the conductive strands includes silver.

[c61] 61. The patient warming device of claim 55 wherein the conductive portion of each of the conductive strands includes silver having a thickness of about 100 microns or less.

[c62] 62. The patient warming device of claim 55, wherein each of the conductive strands includes a nylon core of about 33 denier or less having silver plating with a thickness of about 5 microns or less.

[c63] 63. The patient warming device of claim 55, further comprising a plurality of non-conductive strands, wherein each of the non-conductive strands is entwined with at least one of the conductive strands to form a plurality of conductive yarns, and wherein the plurality of conductive yarns are interwoven with the flexible substrate.

[c64] 64. The patient warming device of claim 55, further comprising:

a first conductive lead supported by the flexible substrate, the first conductive lead coupled to the plurality of conductive strands and configured to be biased at a first electrical potential; and

a second conductive lead supported by the flexible substrate and spaced apart from the first conductive lead, the second conductive lead coupled to the plurality of conductive strands and configured to be biased at a second electrical potential to cause electrical current to flow through each of the conductive strands and generate heat.

[c65] 65. The patient warming device of claim 55 wherein the conductive strands are at least generally radiolucent.

[c66] 66. The patient warming device of claim 55 further comprising a temperature sensing device positioned at least proximate to the conductive strands and configured to respond to changes in temperature of the warming device, wherein the temperature sensing device is at least generally radiolucent.

[c67] 67. The patient warming device of claim 55 further comprising an optical temperature sensing device positioned at least proximate to the conductive strands and configured to respond to changes in temperature of the warming device, wherein the optical temperature sensing device is at least generally transparent to x-rays.

[c68] 68. The patient warming device of claim 55 further comprising an optical temperature sensing device positioned at least proximate to the conductive strands and configured to respond to changes in temperature of the warming device, wherein the optical temperature sensing device includes a thermal chromatic liquid crystal.

[c69] 69. The patient warming device of claim 55 wherein the support portion includes a compressible foam portion that at least generally overlays the flexible substrate.

[c70] 70. The patient warming device of claim 55 wherein the support portion includes a first foam pad disposed adjacent to a first surface of the flexible substrate, and further comprising a second foam pad disposed adjacent to a second surface of the flexible substrate opposite the first surface of the flexible substrate.

[c71] 71. The patient warming device of claim 55 wherein the support portion includes an upper foam pad disposed adjacent to an upper surface of the flexible substrate, the upper foam pad having a thickness of about 1.0 inch or less.

[c72] 72. The patient warming device of claim 55 wherein the support portion includes an upper foam pad disposed adjacent to an upper surface of the flexible substrate, the upper foam pad having a thickness of about 0.5 inch or less.

[c73] 73. A patient warming device usable to warm a person, the patient warming device comprising:

a support portion configured to support at least part of the person;

a flexible substrate positioned at least proximate to the support portion; and

at least one conductive path defining a non-linear pattern extending across at least a portion of the flexible substrate, wherein the conductive

path is configured to generate heat to warm the person when the person is positioned at least partially on the support portion.

[c74] 74. The patient warming device of claim 73 wherein the at least one conductive path defines a repeating geometric pattern extending across at least a portion of the flexible substrate.

[c75] 75. The patient warming device of claim 73 wherein the at least one conductive path defines a repeating Greek key pattern extending across at least a portion of the flexible substrate.

[c76] 76. The patient warming device of claim 73 wherein the at least one conductive path includes a first conductive path defining a non-linear pattern, and further comprising at least a second conductive path defining an at least generally linear pattern extending across at least a portion of the flexible substrate, wherein the second conductive path is configured to generate heat by conducting electricity.

[c77] 77. The patient warming device of claim 73 wherein the at least one conductive path includes a first conductive path defining a non-linear pattern, and further comprising at least a second conductive path defining an at least generally linear pattern extending across at least a portion of the flexible substrate, wherein the second conductive path is configured to generate heat by conducting electricity, and wherein the second conductive path intersects the first conductive path at at least one location on the flexible substrate.

[c78] 78. The patient warming device of claim 73 wherein the flexible substrate includes a cloth material, and wherein the at least one conductive path includes a plurality of conductive strands interwoven with the cloth material.

[c79] 79. The patient warming device of claim 73 wherein the flexible substrate includes a cloth material, wherein the at least one conductive path includes a plurality of silver strands interwoven with the cloth material.

[c80] 80. The patient warming device of claim 73 wherein the conductive paths are at least generally transparent to x-rays.

[c81] 81. The patient warming device of claim 73 further comprising a temperature sensing device positioned at least proximate to the at least one conductive path and configured to respond to changes in temperature of the warming device, wherein the temperature sensing device is at least generally transparent to x-rays.

[c82] 82. The patient warming device of claim 73 further comprising an optical temperature sensing device positioned at least proximate to the at least one conductive path and configured to respond to changes in temperature of the warming device, wherein the optical temperature sensing device is at least generally transparent to x-rays.

[c83] 83. The patient warming device of claim 73 further comprising an optical temperature sensing device positioned at least proximate to the at least one conductive path and configured to respond to changes in temperature of the warming device, wherein the optical temperature sensing device includes a thermal chromatic liquid crystal.

[c84] 84. The patient warming device of claim 73 wherein the support portion includes a compressible foam portion that at least generally overlays the flexible substrate.

[c85] 85. The patient warming device of claim 73 wherein the support portion includes an upper foam pad disposed adjacent to an upper surface of the flexible substrate, the upper foam pad having a thickness of about 1.0 inch or less.

[c86] 86. The patient warming device of claim 73 wherein the support portion includes a plurality of individual foam particles.

[c87] 87. A personal warming device usable to warm a patient, the personal warming device comprising:

a flexible heating element; and

a compressible layer positioned proximate to the heating element and configured to support at least a portion of the patient, the compressible layer having a thickness of about 0.5 inch or less, wherein the heating element is configured to generate heat by conducting electricity when a patient is positioned on the compressible layer.

[c88] 88. A patient warming device usable to warm a person, the patient warming device comprising:

a contoured support portion having at least one contoured surface configured to support at least part of the person; and

a heating element positioned at least proximate to the contoured support portion, the heating element including:

a flexible substrate; and

a plurality of conductive strands supported by the flexible substrate, each of the conductive strands having a core portion and a conductive portion carried by the core portion, wherein each of the conductive strands is configured to generate heat by conducting electricity.

[c89] 89. The patient warming device of claim 88 wherein the flexible substrate includes a cloth material, and wherein the plurality of conductive strands are interwoven with the cloth material.

[c90] 90. The patient warming device of claim 88 wherein the flexible substrate includes a cloth material, wherein each of the conductive strands includes metallic plating, and wherein the plurality of conductive strands are interwoven with the cloth material.

[c91] 91. The patient warming device of claim 88 wherein the core portion of each of the conductive strands is at least generally non-conductive.

[c92] 92. The patient warming device of claim 88 wherein the plurality of conductive strands define a non-linear pattern extending across at least a portion of the flexible substrate.

[c93] 93. The patient warming device of claim 92 wherein the non-linear pattern includes a repeating geometric pattern extending across at least a portion of the flexible substrate.

[c94] 94. A patient warming device usable to warm a person, the patient warming device comprising:

a compressible fill layer having a thickness of about 0.5 inch or less;

a flexible substrate positioned at least proximate to the fill layer;

at least one conductive path defining a repeating geometric pattern extending across at least a portion of the flexible substrate, wherein the conductive path is configured to generate heat by conducting electricity; and

a form-fitting cover enclosing the fill layer, the flexible substrate, and the conductive path.

[c95] 95. The patient warming device of claim 94 wherein the at least one conductive path defines a repeating Greek key pattern extending across at least a portion of the flexible substrate.

[c96] 96. The patient warming device of claim 94 wherein the flexible substrate includes a cloth material, and wherein the at least one conductive path includes a plurality of conductive strands interwoven with the cloth material.

[c97] 97. The patient warming device of claim 94 wherein the conductive paths are at least generally transparent to x-rays.

[c98] 98. The patient warming device of claim 94 further comprising a temperature sensing device positioned at least proximate to the at least one conductive path and configured to respond to changes in temperature of the warming device, wherein the temperature sensing device is at least generally transparent to x-rays.

[c99] 99. The patient warming device of claim 94 wherein the fill layer includes a compressible foam portion that at least generally overlays the flexible substrate.

[c100] 100. The patient warming device of claim 94, further comprising one or more magnets positioned within the cover at least proximate to the fill layer.

[c101] 101. A method for controlling the temperature of a personal warming device, the personal warming device including a heating element, the method comprising:

receiving a selection from a user for a first temperature, the first temperature being related to the temperature at a surface of the personal warming device; and

in response to receiving the temperature selection, warming the heating element to a second temperature, the second temperature being higher than the first temperature.

[c102] 102. The method of claim 101, further comprising:

measuring the temperature of the heating element; and

if the temperature of the heating element exceeds the second temperature, at least temporarily cutting-off power to the heating element.